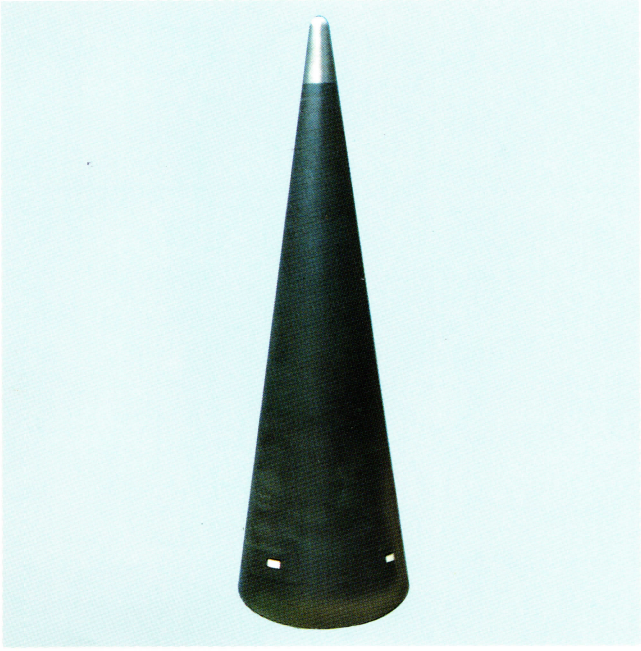
MK12A NOSETIP

Avco Systems Division has been selected by the USAF as the supplier of carbon-carbon nosetip assemblies for the Minuteman III (MMIII) MK12A Reentry Vehicle.

The nosetip is a 3D FINEWEAVE-PIERCED™ Fabric (FWPF) carbon-carbon material developed under programs sponsored by BMO and AFML. The development of the 3D carbon-carbon FINEWEAVE-PIERCED™ Fabric material is the culmination of several years of development effort which was geared toward producing a high quality aerospace grade material capable of attaining the increased performance requirements and survivability in the extreme environments associated with ICBM reentry. The 3D carbon-carbon nosetip, which replaces the baseline carbon phenolic nosetip, has shown that the overall performance of the MMIII MK12A reentry vehicle has been significantly improved. This has been demonstrated through improvements in the reentry recession rates to less than one half that of carbon phenolic with good shape stability that promotes lower vehicle trims resulting in increased accuracy.



With these demonstrated improvements the FWPF was engineered to meet the geometric envelope constraints of the MMIII MK12A configuration. This led to a design of a nosetip assembly for the MMIII MK12A reentry vehicle which consists of a 3D carbon-carbon plug tip, a carbon phenolic collar, and an aluminum nose shell bonded together with an epoxy adhesive. During reentry the carbon-carbon nosetip is subjected to extreme temperature, pressure and weather environments. The carbon-carbon ablates during reentry but experiences no significant recession until temperatures in excess of 5000°C are encountered. As the temperature and pressure environments decrease in severity away from the stagnation and sonic point location on the tip, the transition from carbon-carbon to carbon phenolic can be accommodated.

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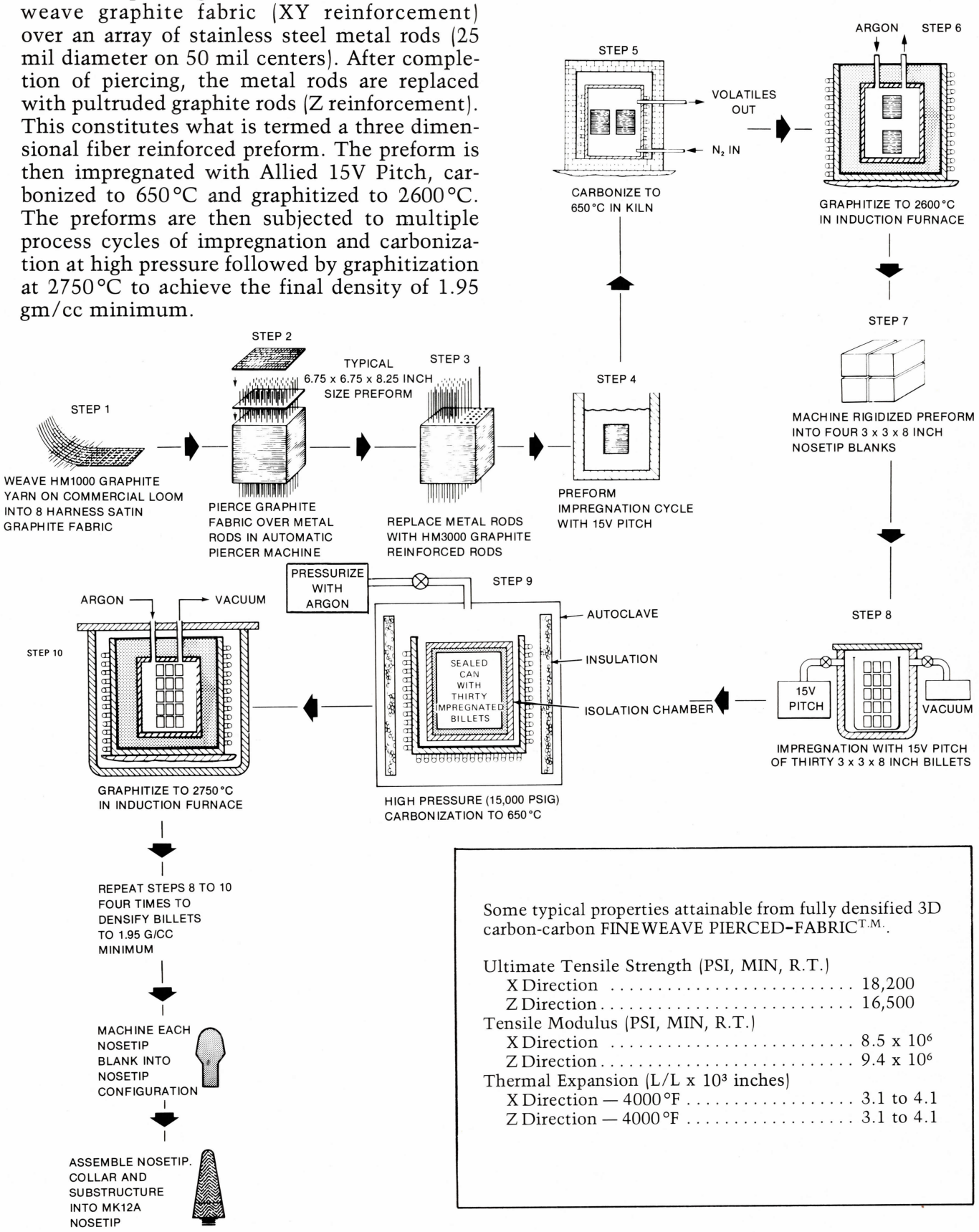
The 3D carbon-carbon nosetip material is fabricated utilizing unique equipment developed by Avco Systems Division. The process consists of piercing an 8 harness HM1000 satin weave graphite fabric (XY reinforcement) over an array of stainless steel metal rods (25 mil diameter on 50 mil centers). After completion of piercing, the metal rods are replaced with pultruded graphite rods (Z reinforcement). This constitutes what is termed a three dimensional fiber reinforced preform. The preform is then impregnated with Allied 15V Pitch, carbonized to 650 °C and graphitized to 2600 °C. The preforms are then subjected to multiple process cycles of impregnation and carbonization at high pressure followed by graphitization at 2750 °C to achieve the final density of 1.95 gm/cc minimum.


STEP 1
WEAVE HM1000 GRAPHITE YARN ON COMMERCIAL LOOM INTO 8 HARNESS SATIN GRAPHITE FABRIC
STEP 2
TYPICAL 6.75 x 6.75 x 8.25 INCH SIZE PREFORM
PIERCE GRAPHITE FABRIC OVER METAL RODS IN AUTOMATIC PIERCER MACHINE
STEP 3
REPLACE METAL RODS WITH HM3000 GRAPHITE REINFORCED RODS
STEP 4
PREFORM IMPREGNATION CYCLE WITH 15V PITCH
STEP 5
VOLATILES OUT
N_2 IN
CARBONIZE TO 650 °C IN KILN
ARGON
STEP 6
GRAPHITIZE TO 2600 °C IN INDUCTION FURNACE
STEP 7
MACHINE RIGIDIZED PREFORM INTO FOUR 3 x 3 x 8 INCH NOSETIP BLANKS
STEP 8
15V PITCH
VACUUM
IMPREGNATION WITH 15V PITCH OF THIRTY 3 x 3 x 8 INCH BILLETS
STEP 9
PRESSURIZE WITH ARGON
AUTOCLAVE
INSULATION
ISOLATION CHAMBER
SEALED CAN WITH THIRTY IMPREGNATED BILLETS
HIGH PRESSURE (15,000 PSIG) CARBONIZATION TO 650 °C
STEP 10
ARGON
VACUUM
GRAPHITIZE TO 2750 °C IN INDUCTION FURNACE
REPEAT STEPS 8 TO 10 FOUR TIMES TO DENSIFY BILLETS TO 1.95 G/CC MINIMUM
MACHINE EACH NOSETIP BLANK INTO NOSETIP CONFIGURATION
ASSEMBLE NOSETIP, COLLAR AND SUBSTRUCTURE INTO MK12A NOSETIP

Some typical properties attainable from fully densified 3D carbon-carbon FINEWEAVE PIERCED-FABRIC™.

Ultimate Tensile Strength (PSI, MIN, R.T.)	
X Direction	18,200
Z Direction	16,500
Tensile Modulus (PSI, MIN, R.T.)	
X Direction	8.5×10^6
Z Direction	9.4×10^6
Thermal Expansion (L/L x 10^3 inches)	
X Direction — 4000 °F	3.1 to 4.1
Z Direction — 4000 °F	3.1 to 4.1

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